Two experiments (Exp.) were conducted to determine the AME content of refined soybean oil (SO), recycled soybean oil (RSO), and acidulated soybean oil soapstocks (ASO) and the effects of inclusion of vitamin E and vitamin C in diets containing 3.5% of these soy oils on performance and egg quality of Hy-line hens from 44 to 56 wks of age. In Exp. 1 the AME of the 3 experimental oils were determined in adult cocks using 6 individual replicates per treatment. The apparent total tract digestibility (ATTD) of SO, RSO, and ASO were measured by 1) difference between AME values of the basal diet without any oil added and that of the diet based on 95% basal diet and 5% of the experimental oil, and 2) directly multiplying the ATTD of the ether extract fraction of the diet by the GE of the oil. The determined ATTD were 95.2, 94.5, and 85.9% for SO, RSO, and ASO, respectively. The AME of the oils were 9,138, 8,955, and 7,961 kcal/kg measured by the substitution method, and 8,916, 8,880, and 7,849 kcal/kg calculated directly from the ATTD coefficient of the ether extract, respectively. In Exp. 2 there were 12 treatments arranged factorially with 3 oil sources (SO, RSO, and ASO), 2 levels of vitamin E (0 vs. 250 mg/kg), and 2 levels of vitamin C (0 vs. 250 mg/kg). Each diet was replicated 5 times and the experimental unit was formed by 5 hens caged together. The trial was conducted under moderate temperature conditions (21 ± 3°C and 50% humidity) and lasted for 12 wks (44 to 56 wks of age). For the entire experimental period, diet did not affect laying hen performance or egg quality traits. It is concluded that recycled oil and acidulated soybean oil soapstocks are good alternatives to refined soybean oil in diets for laying hens. Under the conditions of this research, the supplementation of the diet with extra amounts of vitamin E and C to improve egg production or egg quality is not justified.

Key Words: apparent metabolizable energy, laying hen performance, soy oil sources, vitamin C, vitamin E

959 Influence of soy oil source and supplementation of the diet with vitamin E and vitamin C on performance and egg quality of Single Comb White Leghorn laying hens from forty four to fifty six weeks of age. H. Irandoost1, A. H. Samie1, H. R. Rahmani1, J. Pourreza1, M. Kadivara2, M. A. Edriss1, P. García-Rebollar3, and G. G. Mateos3, 1Department of Animal Sciences, Isfahan University of Technology, Isfahan, Iran, 2Department of Food Science and Technology, Isfahan University of Technology, Isfahan, Iran, 3Departamento de Producción Animal, Universidad Politécnica de Madrid, Spain.

The advantage of organic selenium over inorganic selenium in animal diets has been well documented. To gain further insights into biological functions at the molecular level, this study investigated the effects of dietary sodium selenite (SS) or organic yeast selenium Sel-Plex (SP, Alltech Inc.) on the hepatic gene expression profiles of laying hens. Hens were assigned at age of 6 wks to one of 3 treatments: basal semi-purified diet (control), basal diet + 0.3 ppm SP or basal diet + 0.3 ppm SS. At 49 wks, liver samples were collected and used for gene expression analysis. Results indicated that 1039 transcripts were differentially regulated by SP (508 down, 531 up, \( P < 0.01, \text{FC} > 1.2 \)), while 514 transcripts were altered by SS (207 down, 307 up, respectively). They were 135 transcripts commonly changed by SP and SS. Further pathway analysis revealed the significant upregulation of genes involved in energy metabolism and other mitochondrial functions including oxidative phosphorylation and ubiquinone biosynthesis pathways by SP, while similar effects were not observed in SS-fed chickens. Genes involved in signaling pathways that are important in response to cellular stress and injury such as P53 signaling (e.g., CCNK, GADD45B) and production of nitric oxide and reactive oxygen species were also suppressed by SP. On the other hand, increased expression of multiple genes that have been linked with development of certain liver diseases, such as aryl hydrocarbon receptor (AHR), nuclear factor kappa (NFKB1) and microsomal glutathione S-transferase 2 (MGST2) by SS may suggest an increased risk of hepatic system diseases when high levels of inorganic selenium are added to the diets of hens. This study indicates that differences in liver gene expression profiles, especially on genes involved in energy production and cellular stress, may partially explain the reported biological differences related to SP and SS.

Key Words: selenos, gene expression, liver, hen, microarray
An experiment was conducted to investigate the effects of graded levels of dietary sodium (0.15, 0.20, 0.25 and 0.30% Na) on live performance and development of footpad dermatitis (FPD) in broiler chickens reared to 49 d of age. On the day of hatch, 1280 mixed sex chicks were randomly allotted to 4 treatments with 8 replicate pens of 40 broilers per pen. A 3-stage feeding program, consisting of a starter, grower, and finisher feeds, as well as water were provided ad libitum and lighting was continuous throughout the study. Litter samples were collected, pooled by pen and analyzed for moisture at 0 and 49 d of age. FPD incidence and severity were assessed by examining all birds on Days 28 and 49. Data were statistically analyzed for linear (L), quadratic (Q) and cubic (C) treatment effects by the GLM procedure of SAS. Dietary supplementation of broiler diets with graded levels of Na improved (P < 0.05) feed conversion ratio on Day 14 (L and Q), BW on Days 28 and 49 (L), decreased mortality on Day 49 (L), increased total water consumption (L) and water to feed ratio (C). Liner moisture level also increased (P < 0.001) linearly from 24% (0.15% Na) to 32% (0.30% Na) on Day 49. Moreover, the incidence and severity of FPD on Days 28 and 49 increases linearly with Na levels in the diet. On Day 49, FPD severity was worst on treatments receiving the 2 highest levels of Na. These results confirm the earlier reports that high dietary Na can increase litter moisture and hence be a direct trigger of FPD development in broiler chickens.

Key Words: broiler, sodium, footpad dermatitis, performance

599 Performance and egg iron contents of Cobb 500 female broiler breeders fed diets having meat meal or iron-amino acid. F. Bessa1, S. L. Vieira1, E. Allix1, P. C. Nascimento2, and A. Favero1, 1Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, 2Universidade Federal de Santa Maria, Santa Maria, RS, Brazil.

The objective of this study was to compare diets with or without animal by-product and different Fe supplementation in broiler breeder diets. Sixty Cobb 500 females, 22 wks of age, were placed individually in cages and fed a typical breeder diet (15.6% CP, 2,840 kcal ME/kg, 3.2% Ca, 0.45% Av P) without Fe supplementation for 84 d. Starting on d 85, birds were randomly allocated to 6 dietary treatments in a factorial of 2 diets (Vegetable and Animal) and 3 Fe sources (None, Inorganic and Chelated). Diets had similar nutrient profile with the exception of Fe. Vegetable diet was formulated with corn, wheat bran and soybean meal, whereas the Animal diet had the inclusion of 2.5% meat and bone meal. The None diet was not supplemented with Fe, whereas 60 ppm of Fe was supplemented in the Inorganic (Fe (II) sulfate) or in the Chelated (Fe-amino acid: 6% Fe, with varying percentages of AA). Diets were provided for 3 periods of 4 wks and eggs were collected daily. In the last 2 d of each week, eggs were weighed, and yolks and albumen were separated. Egg composites were frozen for further analysis of Fe content using atomic absorption spectroscopy. Resulting data were analyzed using a 2-way ANOVA with repeated measures. Yolk Fe contents increased with time in all treatments, except for the Vegetable diet without Fe supplementation (P < 0.05). Average Fe concentration in yolk was the highest for the Animal diet supplemented with Fe-AA, lowest for the Vegetable diet not supplemented with Fe, and without differences between the other 4 treatments. Egg production was reduced for birds fed both diets without Fe supplementation when compared with those with any type of Fe supplementation (P < 0.05). No differences were found for egg weight, specific gravity, or for the weight of egg yolk, albumen or shell (P > 0.05). In conclusion, Fe concentration was increased when 60 ppm of Fe from ferric sulfate or Fe-AA sources were added to breeder diets traditionally formulated without meat and bone meal, but Fe was further increased in Animal diets when Fe-AA was used.

Key Words: broiler breeder, chelated mineral, egg contents, iron

600 Effect of dietary zinc proteinate on growth performance, and skin and meat quality of male and female broiler chicks. H. M. Salim1,2, H. R. Lee1, C. Jo3, S. K. Lee1, and B. D. Lee*1, 1Department of Animal Science and Biotechnology, Chungnam National University, Daejeon, South Korea, 2Department of Livestock Services, Dhaka, Bangladesh.

Two experiments were conducted to evaluate the effect of dietary zinc proteinate (ZP) on growth performance, and skin and meat quality of broiler chicks. In both experiments, 120 each of 1-d-old male and female broiler chicks were allotted to 2 dietary levels of ZP (2 × 2 factorial) with 6 replicates per treatment, and 20 birds per replicate. The ZP levels were 0 and 25 ppm in Exp. 1, and 0 and 40 ppm in Exp. 2. In Exp. 1, ZP did not affect the growth performance of male and female broiler chicks, but the males showed significantly higher (P < 0.05) growth performance than females. ZP did not affect the thickness of both back and thigh skin of male and female broilers; however, male had thicker skin than females. Dietary ZP did not affect the collagen contents in skin and meat samples. Males had higher skin collagen contents than females, but no sex difference was found in meat collagen contents. ZP did not affect the shear force values of skin and meat samples. Males had higher shear force values of back skin than females, but not in the meat samples. In Exp. 2, ZP did not affect the growth performance of males and females, but males showed better growth performance than did females. ZP increased the total thickness of skin samples in both sexes, and males had thicker skin than females as in Exp. 1. Dietary ZP increased (P < 0.05) the collagen content of skin samples, but not in meat samples. Like in Experiment 1, males had higher skin collagen contents than females, but no sex difference was found in meat collagen contents. ZP did not affect the shear force values of skin and meat samples; however, male broilers had higher shear force values of back skin than females. It is concluded that dietary ZP could increase the collagen content and skin thickness which, in turn, would improve the skin and meat quality of broiler chicks. Females had lower collagen content and thinner skin than males, indicating a higher ZP requirement for females than its counterpart.

Key Words: zinc proteinate, skin quality, growth, male broilers, female broilers

601 Identification of copper and manganese glycinate complexes in enriched feeds and study of their bioavailable forms using capillary electrophoresis coupled with inductively coupled plasma mass spectrometry (CE-ICP-MS). C. Ionescu*,1, V. Vacchina2, R. Lobinski3, and D. M. Bravo1, 1Pancosma, Geneva, Switzerland, 2UT2A, Pau, France, 3CNRS, Pau, France.

Poultry feeds contain copper and manganese supplements. Some organic trace minerals have shown better absorbability than inorganic sources and raised the concern for trace mineral dose reduction in diets. However, feed efficacy with lower copper and manganese doses could be different from one organic trace mineral source to another increasing the feed producer concerns for organic trace minerals sources iden-
compared with inorganic sources. However, sources differences were
Organic trace mineral (OTM) efficiency have been heavily studied
concentrations. A total of 384 male broilers Ross 308 were held in
ity.
602 Feeding organic trace minerals source instead of inorganic
glycinate complex, feed, traceability, chelates
Key Words: organic trace minerals, glycinate complexes, carcass
quality, broiler

603 Inclusion of organic selenium on performance and egg
quality of Japanese quails at 56 to 76 d old. V. C. da Cruz*1, L.
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versity, Botucatu, São Paulo, Brazil.
This study was carried out at São Paulo State University, Dracena
Campus, Brazil, to evaluate the performance and egg quality of Japa-
nese quails supplemented with organic zinc and chromium associated
with different inclusions of selenium also in organic form. The experi-
mental design was completely randomized and birds were allocated to
the following treatments: T1 = basal diet - without chelated minerals,
T2 = 0.25 ppm Se + 60 ppm Zn + 0.5 ppm Cr, T3 = 0.50 ppm Se + 60
ppm Zn + 0.5 ppm Cr, T4 = 0.75 ppm Se + 60 ppm Zn + 0.5 ppm Cr,
T5 = 1.00 ppm Se + 60 ppm Zn + 0.5 ppm Cr; with 8 replications of 5
birds per treatment. In the period from 56-d to 76-d old was observed
by regression analysis that there was no significant difference (P >
0.05) in performance: dozen eggs produced, average egg weight, feed
intake, feed conversion by egg mass (kg feed/kg eggs) and feed con-
version by egg dozen (kg feed/dozen eggs), daily egg production and
feed intake per bird. The yolk height decreased linearly (P < 0.05) and
albumen index had a quadratic effect (P < 0.05), with better results
observed for both in the eggs of birds submitted to the consumption
of inorganic minerals. No significant effects (P > 0.05) of treatments
were observed for Haugh unit, specific egg weight, albumen height,
yolk index, shell weight and shell thickness, agreeing with previous
research that assessed organic minerals in the diet of laying hens and
also found no advantages in its use. Despite presenting higher bio-
availability and easier absorption by the animal, supplementation with
chelated minerals in this study did not influence the internal and exter-
nal quality of eggs and did not improve quails performance. The lack
of response of supplementing chelated minerals may be explained not
only by different doses of selenium, but also by the use of different
sources.
Key Words: chelated mineral, mineral supplement, trace element,
selenium methionine, Coturnix coturnix japonica

604 Effect of dietary vitamin E on tocopherol content and fatty
acid profile of liver. J. Viguera1, O. Caso2, A. Ayllo3, M. D’Arrigo3,
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3INIA, Soria, Spain.
Ducks overfed with a carbohydrate-rich diet for less than 2 weeks
develop a fatty liver (foie gras), which has a high susceptibility to lipid
oxidation, which could be reduced with vitamin E supplementation.
A trial was conducted to investigate the effects of dietary vitamin E
supplementation on tocopherol content of liver. Three-hundred seventy-
five male Mulard ducks were assigned to one of 3 dietary groups. Con-
trol group received the control diet with corn grain and corn meal.
In addition to the control diet, 2 experimental diets included 200 mg
vitamin E/kg (T2), and 400 mg vitamin E/kg (T3). Animals were fed
with a common diet from birth to the overfeeding period. At 12 weeks
of age, all ducks were housed in individual cages and were overfed
at the maximum of their ingestion potential for 14 d with its respec-
tive diet. At the end of this period, animals were slaughtered under
commercial conditions and all livers were weighed. Then, 17 livers of
each treatment were collected to analyze α and γ tocopherol content

Key Words: organic trace minerals, glycinate complexes, carcass
quality, broiler
and fatty acid profile. All data were analyzed by ANOVA with diet as main effect. No significant differences were found between treatments for carcass weight. However, vitamin E supplementation reduced liver weight (573.2 vs 605.4 g; \( P < 0.05 \)) and tended to decrease liver yield (17.22 vs 18.14%; \( P = 0.08 \)) compared with control ducks. Animals with vitamin E supplementation showed greater \( \alpha \)-tocopherol content of the liver than control ducks (5.65 vs 0.50 mg/g; \( P < 0.01 \)), but no significant differences between treatments were found for \( \gamma \)-tocopherol content. Vitamin E supplementation did not affect fatty acid profile of the liver. In conclusion, dietary vitamin E supplementation in ducks increases the \( \alpha \)-tocopherol level in the liver, which seems to be a valuable method for increasing the antioxidant capacity of the liver.

**Key Words:** duck, vitamin E, tocopherol, liver

### 605 Effect on omega 3 fatty acids egg content and productive parameters when laying hens diets are supplemented with sardine oil and vitamin E

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Several authors have observed that when laying hens diets are supplemented with fish oil (FO) levels up to 1.5%, the omega 3 fatty acid egg content increase, but the egg weight and egg production decrease. As seem, adding more vitamin E at the rations, this problem can be avoided, and the loss of EPA and DHA due to oxidation, too. The aim of this study was to know the effect on omega 3 fatty acids egg content and productive parameters, when laying hens diets are supplemented with sardine oil (SO) and \( \alpha \)-tocopherol (ATA). 240 laying hens were distributed into 4 treatments with 5 replicates of 12 birds each one. The treatments were: T1-basal diet (BD), T2-BD+2.5%SO, T3-BD+5.0%SO+100ATA and T4-BD+2.5%FO+200ATA. The study was carried out during 4 weeks. At end 50 egg per treatment (10 per replicate) were taken to fatty acids analysis, by gas chromatography. The results showed any effect on egg FA content and productive parameters when 100 mg/kg ATA were added to laying hens diets, but when 200 mg/kg ATA were added, the egg FA content was reduced, mainly the omega 3 FA (\( P < 0.05 \)). It is concluded that adding high levels of ATA (200 mg/kg) in the laying hens supplemented with sardine oil can decrease the egg fatty acid content.

**Key Words:** Fatty acids, sardine oil, vitamin E, eggs, laying hens

### 606 The effect of selenomethionine vs. sodium selenite supplementation on vitelline membrane strength, glutathione peroxidase activity in the liver and magnum of laying hens, and egg se content when using a corn starch based diet

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The objective of this study was to investigate the effects of dietary selenium (Se) source and level on production parameters of laying hens fed a semi-purified diet. A total of 90 White Bovan hens were fed the experimental diets for 6 weeks. Hens were assigned to 30 cages with 6 replicate cages/treatment. Cages were blocked by side, north and south, each side with a total of 15 cages. Hens were fed a semi-purified corn starch-soybean meal diet supplemented with: (0, 0.2 ppm selenomethionine, 0.2 ppm sodium selenite (SS), 0.4 ppm selenomethionine, or 0.4 ppm SS) for a total of 5 dietary treatments in a factorial treatment design. Three eggs per treatment were collected 3 times throughout the study for yolk and albumen Se content. At the end of the study, 2 hens/ cage were euthanized to measure GSH-Px activity of the liver and magnum tissues. Feed intake and egg production increased as dietary Se supplementation increased in the diet but this was significant only with feed intake (\( P < 0.05 \)). Hens supplemented with selenomethionine consumed more feed compared with the inorganic source of Se (\( P < 0.05 \)). Yolk Se content was significantly higher in all treatments supplemented with Se than the control diet (\( P = 0.0497 \)). There was a significant interaction effect of Se source and level on albumen Se content (\( P = 0.0358 \)); albumen Se content increased when selenomethionine levels in the diet increased, whereas when sodium selenite levels increased in the diet, there was no significant increase in egg albumen Se content. Dietary treatments had no significant effects on egg quality parameters or GSH-Px activity in the liver and magnum of hens. Our research hypothesis was that the semi purified basal diet used should have low Se content to show significant effects on egg quality and production parameters, but the results showed the basal diet had higher amounts of Se (417.5 ppb) than regular diets that met minimum requirements of the laying hen of 0.06 ppm (NRC, 1994).

**Key Words:** vitelline membrane strength, glutathione peroxidase, egg Se content

### 607 Performance of Pearl Grey guinea fowl fed diets varying in calcium and available phosphorus concentrations

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The demand for guinea fowl (GF) as alternative poultry has been steadily increasing worldwide. However, their production performance lags that of other commercial avian species partly because there is insufficient knowledge of their nutrient requirements. Dietary calcium (Ca) and phosphorus requirement for optimum growth performance of the Pearl Grey GF replacement pullets was evaluated. In a 4 × 3 factorial arrangement of dietary treatments, 540 Pearl Grey GF (1-d-old) were assigned to brooding cages and fed diets containing 0.6, 0.8, 1.0 and 1.2% calcium each in combination with 0.32, 0.4, or 0.48% available phosphorus (AP). The starter diets were isocaloric 3,000 kcal/kg ME and isonitrogenous (24% CP) and were fed from 8 weeks of age (WOA). The grower diets comprised of 3,100 kcal/kg ME and 18% CP and were fed from 9-15 WOA. The diets were replicated four times and both feed and water were provided at free choice. The birds were reared on a 23 and 8 hour lighting regimen at 0-8 WOA and 9-15 WOA, respectively. Experimental birds were observed for feed consumption (FC), BW gain and feed conversion ratio (FCR). Birds fed diets containing 0.6% Ca and 0.4-0.8% AP exhibited higher (\( P < 0.05 \)) FC than other treatments. Average FCR was lower in birds fed diets containing 0.8% Ca and 0.32-0.48% P than other dietary treatments. In most part, BW gains were not different among dietary treatments except for birds fed the 0.6% Ca and 0.32% AP whose BW gain was higher than other treatments. Therefore, the Pearl Grey guinea fowl seems to utilize more efficiently diets containing 0.8% Ca and 0.32-0.48% AP.

**Key Words:** Pearl Grey guinea fowl, calcium, phosphorus

### 608 The regulation of intestinal folic acid absorption in the laying hen supplemented with increased levels of dietary folic acid

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Different aspects of folic acid (FA) absorption in the intestine of the laying hen have been previously characterized. However, much less is
known about the regulation of this process. A study was conducted to evaluate the effect of increased dietary folic acid (FA) supplementation on the regulation of intestinal FA absorption and the gene expression of the intestinal folate transporters, the proton coupled folate transporters (PCFT) and the reduced folate carrier (RFC). Twenty-four Shaver White hens at 34 wk of age were randomly assigned to receive 1 of 3 dietary treatments (n = 8): 1) basal diet with no supplemental folate, 2) basal diet + 10 mg/kg of FA, and 3) basal diet + 100 mg/kg of FA. A CRD with 3 dietary treatments was used. Data were subjected to PROC GLM and \( t \)-test procedure of SAS. Results showed that relative to the control-fed birds, egg and plasma folate concentrations increased \((P < 0.001)\), while plasma homocysteine decreased \((P < 0.011)\) in birds fed with 10 and 100 mg/kg of FA. With respect to FA absorption, the uptake of FA (nmol\( \cdot 100 \) g tissue\(^{-1} \) min\(^{-1} \)) in the duodenum was downregulated \((P < 0.002)\) (basal = 25.1 ± 1.7; 10 mg FA = 19.7 ± 1.8; 100 mg FA = 18.5 ± 2.1), but the mRNA levels of the duodenal PCFT and RFC genes were not affected by the supplementation of 10 and 100 mg/kg of FA. In the jejunum, the uptake of FA and the mRNA levels of PCFT and RFC genes were not influenced by increased FA supplementation. Overall, these data demonstrated that increased dietary levels of FA resulted in a downregulation of FA absorption in the duodenum, but not in the jejunum of the laying hen. This was not associated with decreased expression of the duodenal PCFT and RFC genes. Therefore, a post-transcriptional or translational regulation of the intestinal folate transporters may be involved in the downregulation of duodenal FA absorption during increased supplementation of dietary FA.

**Key Words:** folic acid, folate transporter, gene expression, egg, laying hen